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ABSTRACT

This paper reports on a study investigating the effects of studying alone or in cooperative-learning groups on the performance of high and low achievers. The effects of completing computer-based instruction using either learner or program control are also examined. A total of 92 sixth-grade students were classified by Stanford Achievement Scores and randomly assigned to group or individual treatments, stratified by achievement scores. Students completed training to enhance small group interaction before completing the computer-based tutorial and posttests. Both high and low achievers in the cooperative treatment increased achievement on program-controlled and learner-controlled computer lessons. The learner-controlled cooperative learning group made more options while checking their concept learning and spent more time interacting with the learner-controlled, computer-based tutorial than the learner-controlled individual learning group. Six statistical tables are appended. (Contains 13 references.) (Author/KRN)

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Title:

The Effects of Cooperative Learning and Learner Control on High- and Low Achievers

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Abstract

We investigated the effects of studying alone or in cooperative-learning groups on the performance of high and low achievers. We also examined the effects of completing computer-based instruction using either learner- or program-control. A total of 92 sixth-grade students were classified by Stanford Achievement Scores and randomly assigned to group or individual treatments, stratified by achievement scores. Students completed training to enhance small group interaction before completing the computer-based tutorial and post-tests. Both high and low achievers in the cooperative treatment increased achievement on program-controlled and learner-controlled computer lessons. The learner controlled cooperative learning group made more options while checking their concept learning, and spent more time interacting with the learner-controlled computer-based tutorial, than the learner-controlled individual learning group.

The Effects of Cooperative Learning and Learner Control on High- and Low Achievers

Designers of instruction agree that it is important to identify how the instructional environment can be organized in order to utilize the relevant cognitive processing capabilities of learners, and to examine the manner in which technology facilitates such processing (Gagné, 1987). One strategy, which is the subject of debate, is the effect of the shared learning procedures that occur when students work in groups in a mediated instructional environment using modern technological media (Hooper & Hannafin, 1988). Although research on cooperative learning has been conducted to maximize the cost-effectiveness of existing media, it is beginning to reveal the cognitive processing potential when students are allowed to make joint decisions regarding their instructional needs (Johnson & Johnson, 1989).

To date, there are few studies that have focused on cooperative learning groups with computer-based instruction, which enable learners to work in program-controlled situations. Another area of research, which has become popular with the increasing use of computers in education, is that related to delegating some instructional decision-making to learners. Using the capabilities of computers, it is possible to incorporate several types of control strategy in the instruction.

The purpose of this study is to examine two factors that influence the effectiveness of computer-based instruction (CBI) on promoting learning: cooperative group learning and learner control. We propose that efficient use of observation and peer modeling (Bandura, 1977) are powerful mediators of improved performance. However, younger or less-skilled learners are often lacking in knowledge of the use of strategies, as well as how to monitor strategy use when given the opportunity to do so. In cooperative learning groups that are heterogeneous with respect to ability, low- and high-ability students will have an opportunity to observe each other's option-selection skills. This research will investigate whether students in cooperative learning groups will help each other monitor the skills required for learner-controlled behavior and improved decision-making, while learning from a computer-based instructional environment. The present study is an attempt to explore the cognitive and metacognitive assumptions underlying choice behavior and performance in a learner-controlled environment. In the current research we hypothesize that children's knowledge, use, and monitoring of cognitive strategies—especially those related to the decisions made during computer-based instruction—may be inefficient, resulting in poor performance and non-strategic use of available options. For example, it is not sufficient to merely provide learners with options in a lesson, without guidance on how to use them wisely (Boyd, Douglas & Lebel, 1984; Tobias, 1987). Learner control can be considered a meta-strategy, in which learners must exercise a high level of self-monitoring.

One of the goals of instruction is to promote independent, life-long learning. This goal may be promoted by encouraging students to exercise learner control. Learner control refers to students' freedom to manipulate the instructional sequence. In CBI, designers may allow students considerable freedom (or they may impose rigid control) to choose the number of examples and questions, which instructional components to complete, and when to quit instruction.

A large body of research suggests that students often perform poorly in learner-controlled conditions (Steinberg, 1989). However, this effect is mediated by achievement. High achievers appear to exercise effective learner control, but low achievers perform particularly poorly under such conditions. Low achievers often lack sufficient self-regulatory strategies to make effective learner-controlled decisions.

The effect of peer interaction on students' proficiency in making effective decisions has not been examined. Yet, related research suggests that low achievers may work effectively in learner-controlled conditions, when paired with a more capable partner. High-achieving students often model effective learning strategies to less capable partners (Bandura, 1977). We predict that students in the learner-controlled conditions will learn more effectively in groups than with individual treatments.

The purpose of this study was to extend previous research comparing the effects of completing CBI in groups and alone. The study examined the effects of cooperative versus individual CBI on the performance of high and low achievers. The study also examined the effects of learner and program control in individual and cooperative treatment. Finally, the study investigated students' option within learner controlled group to see the effects of time and number of options on individual and cooperative treatments.

Method

Subject

A sample of 92 sixth-grade students from a predominantly white suburban school, participated in the study. Participation was voluntary, and only those who had parental consent were included. The standardized reading scores of this sample were obtained from the SAT (Stanford Achievement Test) test battery administered at the beginning of the academic year (Mean= 48.01 , Range= 2 to 95 , SD= 26.95). Students were classified as high or low achievers according to performance on the reading subscale of the Stanford Achievement Test.

Materials

The following materials were used for the study.

Standardized scores

Standardized achievement test scores in reading ability and overall scores were collected at the beginning of academic year and before the study. Because the experimental content is highly verbal (textual) in nature, these scores were used to form the heterogeneous learning pairs. Reading ability has been found to predict performance in a learner-controlled task based on science content (eg., Kinzie, Berdel and Sullivan, 1988).

Computer-Based tutorial

The computer-based tutorial used for the study was designed and developed by the experimenter using biological concepts that were used in another study on learner-control (Relan, 1991). Several steps were involved in the selection of content, design, and development of the tutorial.

Selection of content The topic of Ecology was selected because of the requirement from the principal and sixth-grade teachers in this elementary school. Content was selected with the objective of identifying level of learning outcomes (Gagné, Briggs, and Wager, 1988). Definitions and instances of ecological topics were excerpted from biological ecology texts ranging from sixth-grade to college-level textbooks. These were paraphrased to accommodate the text to the target population according to the purpose of the study.

The topic selected was "Relationships among Organisms," which included two types of relation: friendly and unfriendly. Six topics were identified for inclusion in the lesson: Mutualism, Commensalism, Competition, Parasitism, Exploitation, and Predation.

Post-test. A 25-item multiple-choice test on generalization, based on verbal and inferential learning outcomes, was implemented as both immediate and delayed post-tests. This test was used in previous research and had been tested for reliability ($\alpha = .79$).

Dependent Measures

Three measures were obtained for each individual student: achievement, time, and options. Achievement was obtained through the immediate and delayed post-tests. Time was collected during the computer-based tutorial. Options were the numbers of options that students made during the tutorial in the learner-controlled treatment.

Design The study employed two designs. For individual measures, a randomized block design was employed with two cross-experimental factors, Grouping (individual or cooperative) and Source of Control (learner or program), and one blocking factor, achievement (high or low). Because the effects within treatment levels were not of particular *a priori* interest (i.e., high achievers were always expected to outperform low achievers on the post-tests), the achievement by

treatment interaction effect was partitioned into those effects of more interest in this study. That is, the effects of source of control and Grouping were examined within each achievement level. The full design model is reflect in Table 1. For learner control-based performances, a completely randomized design employed with two crossed-experimental factors:Grouping (individual or cooperative) and Level of Achievement (high or low).

Insert Table 1 about here

Experimental Procedures

During the week before the experiment, students completed a training session. Training lasted approximately 50 minutes, and was completed in an intact class.

Subjects were assigned to treatments using stratified-ramdom sampling. Initially, high-and low achievers were randomly assigned to paired- and individual-treatment groups. For each class, subjects in the paired treatment were ranked within each achievement level group. Partners were assigned by combining students with identical ranks: The highest achiever was paired with the one who scored just below the median; the second highest was paired with the subject who had the second score below the median and so on, such that the student just above the median was paired with the student who had the lowest score. In this way, there was always a difference between partners of at least 1.5 standard deviation in the SAT score, and, heterogeneity among group members was established. Other students worked individually. The immediate post-test was administered on the same day, after the computer-based tutorial. One week following the experiment students completed the delayed post-test individually. Three absentees completed the post-test two days later. Ninety-two subjects completed the study.

Results

The results are presented in two parts. First, results are reported for individuals. Reliabilities and inter-correlations among the dependent measures are presented, followed by separate MANOVAs examining various treatment effects. Subsequently, results are reported for each of two sets of variables on individual students: immediate post-test and delayed post-test. The second set of results are group-based measures. Group-based measures reflect data recorded at each computer. Each pair of students in the cooperative groups produced a common data set and is thus treated as one case.

Calculations were made using the Statistical Package for the Social Sciences (SPSS) 4.0 for Macintosh, (@ 1990, SPSS Inc.). All tests of significance adopted an alpha level of .05. Inconsistent sample sizes reported across the Tables reflect subjects with isolated missing data points.

Individual Results

Inter-correlations and Scale reliabilities The multiple choice test on generalization was used as both immediate and delayed post-tests. A preliminary correlational analysis was performed to examine the relationships among significant variables in the study. Results of this analysis are shown in Table 2. Table 2 presents inter-correlations among all the immediate post-test, delay post-test, reading and overall scores of the Stanford Achievement Test. All achievement variables were highly correlated: The two post-tests were significantly correlated and were also related highly with both reading subscale and over all Stanford achievement scores.

Insert Table 2 about here

Table 3 reports means, standard deviations, and alpha coefficient reliabilities of immediate and delayed post-test. The immediate post-test reliability was .67. The delayed post-test reliability was .73.

Insert Table 3 about here

Post-tests. Table 4 reports the means and standard deviations of immediate and delayed post-test scores for treatment effects within level of achievement groups.

Insert Table 4 about here

The immediate post-test shows that learner control cooperative treatment scores (M=12.75, SD = 4.99) were higher than any other treatment scores, within high achievers. However program control cooperative treatment scores (M=8.91, SD= 3.15) were higher than any other treatments within low achievers.

The delayed post-test also shows that learner control cooperative treatment scores were higher (M= 15.42, SD= 4.34) than any other treatment scores within high achievers. Program control cooperative treatment scores (M=11.36, SD= 2.29) were higher than any other treatments, within low achievers. It appears that the high achievers performed better under the learner-control cooperative treatment than the program-control cooperative treatment and both learner and program control individual treatments. On the other hand, the low achievers performed better under the program-control cooperative treatment than the learner-control cooperative treatment and both program control and learner control individual treatments. However there are no significant differences for the control main effect.

On the delayed post-test, the MANOVA indicated significant effects for grouping within the high achievement group ($F=11.57$, $p<.001$) and for grouping within the low achievement group ($F=4.69$, $p< .05$). Both high and low achievers learned more effectively in the cooperative treatment than in the individual treatment.

Group Results (Learner-controlled options)

Table 5 reports the means of the five performance indicators during the learner-controlled lesson across Grouping (Individual and Cooperative) and two level of achievement (High and Low). Learner control cooperative treatment has the highest means of Time on task and Checking the concept learning.

Insert Table 5 about here

A MANOVA on the five performance indicators (time on task, total checking, total review, total elaborative feedback, and total practice) was performed to compare the differences in performances during learner control between low and high achievers working individually and high and low achievers working in cooperative pairs. Results of the MANOVA indicated that there are significant differences between the two performance indicators, which are the time on task ($df= 2, 27$, $F=8.82$, $p= .001$) and the number of learning checks for each concept ($df= 2, 27$, $F= 4.08$, $p= .028$). Univariate follow up tests indicated that high and low achievers working together in cooperative treatment pairs spent more time and checked their learning more for each concept than high and low achievers working alone. The levels of significant differences are shown in Table 6.

Insert Table 6 about here

Discussion

The purposes of this study were to examine the effects of completing CBI alone and in cooperative learning groups on high and low achievers and effects of studying in learner- and program-controlled treatments. Cooperative learning improved the achievement of both high and low achievers. The cooperative learning groups demonstrated higher delayed post-test achievement than the individual learning groups.

During the learner-controlled lesson, cooperative learning groups spent more time interacting with the lesson; they also checked their concept learning more than those in individual learning groups. We interpret these findings to mean that cooperative learning mediates deeper content processing and that achievement gains are the result of greater exploration in the learning process. These results also support the previous study (Hooper, Temiyakarn, and Williams, 1991, in press). This is important because it challenges the notion that heterogeneous cooperative-learning groups interfere with the performance of high achievers.

However, the learner control effect is mediated by achievement (Carrier and Jonassen, 1988). Most research on learner control suggests that high achievers appear to exercise effective learner control, but low achievers perform particularly poorly under such conditions. Low achievers often lack sufficient self-regulatory strategies to make effective learner-control decisions. However, the effect of peer interaction on students' proficiency in making effective decisions has not been examined. This study suggests that low achievers may work effectively in learner-controlled conditions, when paired with a more capable partner. High-achieving students often model effective learning strategies to less capable partners (Bandura, 1977). This study shows that low achievers in the learner-controlled conditions learned as effectively as in the program-controlled condition when they were in groups than when they were in individual treatments.

The absence of significant achievement differences between program-control and learner-control treatments indicates that some students may have interacted with the lesson content superficially. Previous research indicates that low achievers did poorer using learner control than using program control (Carrier and Jonassen, 1988). However, this study shows no differences between program control and learner control within low achievers. Thus learner control promoted the bigger mean within high achievers.

The results of this study suggest that greater attention should be given to designing CBI for cooperative learning groups, rather than individual learning. CBI and interpersonal interaction promoted by cooperative learning provide encouragement to stay on task and exert mental effort to both low and high achievers. In the cooperative learning environment, high and low achievers

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explore diverse ideas and procedures of learning (McDonald, Dansereau, Garland, Holley, & Collins, 1980). Together, computer-based instruction, learner control, and cooperative learning magnify each others' benefits.

Future research should pay strong attention to using the powerful learner- controlled treatment to improve achievement, and using the cooperative learning to promote learner control, for both high and low achievers. Learner-controlled lessons should be carefully designed for computer-based tutorials. Learner control with advisement may be appropriate to adapt the student to start with a program-controlled environment and gradually move to a completely learner-controlled lesson, when ththeir learning for each conceptey are ready for such strategy. Modifications of this experimental design may enable exploration of other factors that enhance learning within the learner-controlled situation.

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Table 1

MANOVA of treatment effects on the post-tests within low and high achiever groups.

Effect	df	F	p
Immediate			
Blocking factor:			
Achievement Level	1, 91	30.90	.000
Treatments within Low Achievers:			
Grouping	1, 91	2.27	.136
Source of Control	1, 91	.07	.787
Grouping by Source of Control	1, 91	.12	.729
Treatments within High Achievers:			
Grouping	1, 91	.83	.364
Source of Control	1, 91	.64	.425
Grouping by Source of Control	1, 91	1.39	.242
Delay			
Blocking factor:			
Achievement Level	1, 91	21.00	.000
Treatments within Low Achievers:			
Grouping	1, 91	4.69	.033
Source of Control	1, 91	.98	.324
Grouping by Source of Control	1, 91	.84	.363
Treatments within High Achievers:			
Grouping	1, 91	11.57	.001
Source of Control	1, 91	.06	.811
Grouping by Source of Control	1, 91	1.43	.235

Table 2

Correlations between independent and dependent variables of interest in the study.

	Immed. Post-test	Delay Post-test	SAT
SAT Reading	.6539**	.5766**	.8721**
SAT	.6711**	.6406**	
Delay Post-test	.7966**		

Note. ** implies $p<.01$.

Table 3

Means, standard Deviation, and Reliabilities for the achievement Measures

N=92

	Scale Mean	Standard Deviation	Coefficient α
Post-test			
Immediate	10.03	3.93	.67
Delay	10.91	4.34	.73

Table 4

Means and standard deviations of immediate and delay post-test scores by treatments.

Level of Achievement	Level of control and Grouping				
	LC		PC		
	Ind.	Coop.	Ind.	Coop.	Total
Immediate					
High					
N	10	12	11	11	44
Means	10.60	12.75	12.64	12.36	12.14
SD	3.95	4.99	3.67	4.57	4.28
Low					
N	13	12	12	11	48
Means	7.69	8.83	7.08	8.91	8.10
SD	1.93	2.33	1.08	3.15	2.28
Delay					
High					
N	10	12	11	11	44
Means	10.30	15.42	11.36	13.82	12.84
SD	3.40	4.34	4.99	5.90	5.03
Low					
N	13	12	12	11	48
Means	8.00	9.33	8.08	11.36	9.13
SD	2.48	1.72	2.58	2.29	2.60

Note. Maximum points possible = 25.

Table 5
Learner control options

Level of group within learner control	Types of Options				
	Time	Check	Review	Elaborative Feedback	Practice
Individual					
Low achievers					
N	10	10	10	10	10
M	24.00	4.10	.80	5.00	22.20
SD	5.23	3.51	.79	4.83	6.73
High achievers					
N	10	10	10	10	10
M	23.60	3.70	.70	5.30	21.00
SD	2.84	3.34	.82	4.92	4.92
Cooperative					
High & Low					
N	10	10	10	10	10
M	31.20	7.20	.70	8.90	20.60
SD	5.18	1.87	1.06	4.95	4.90
Total					
N	30	30	30	30	30
M	26.67	5.00	.73	6.40	21.27
SD	5.65	3.30	.87	5.06	5.43

Table 6

MANOVA of treatment effects on the options within cooperative learning groups.

Variable	df	F	p
Time on task	2, 27	8.82000	.001
Checking Concept Learning	2, 27	4.08450	.028
Review Each Concept	2, 27	.04128	.960
Elaborative Feedback	2, 27	1.95948	.160
Practice Items	2, 27	.22233	.802

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